Looking Through: Mapping Air

Cassini's Composite Infrared Spectrometer

Stephen J. Edberg

Cassini Program

October 29, 1999

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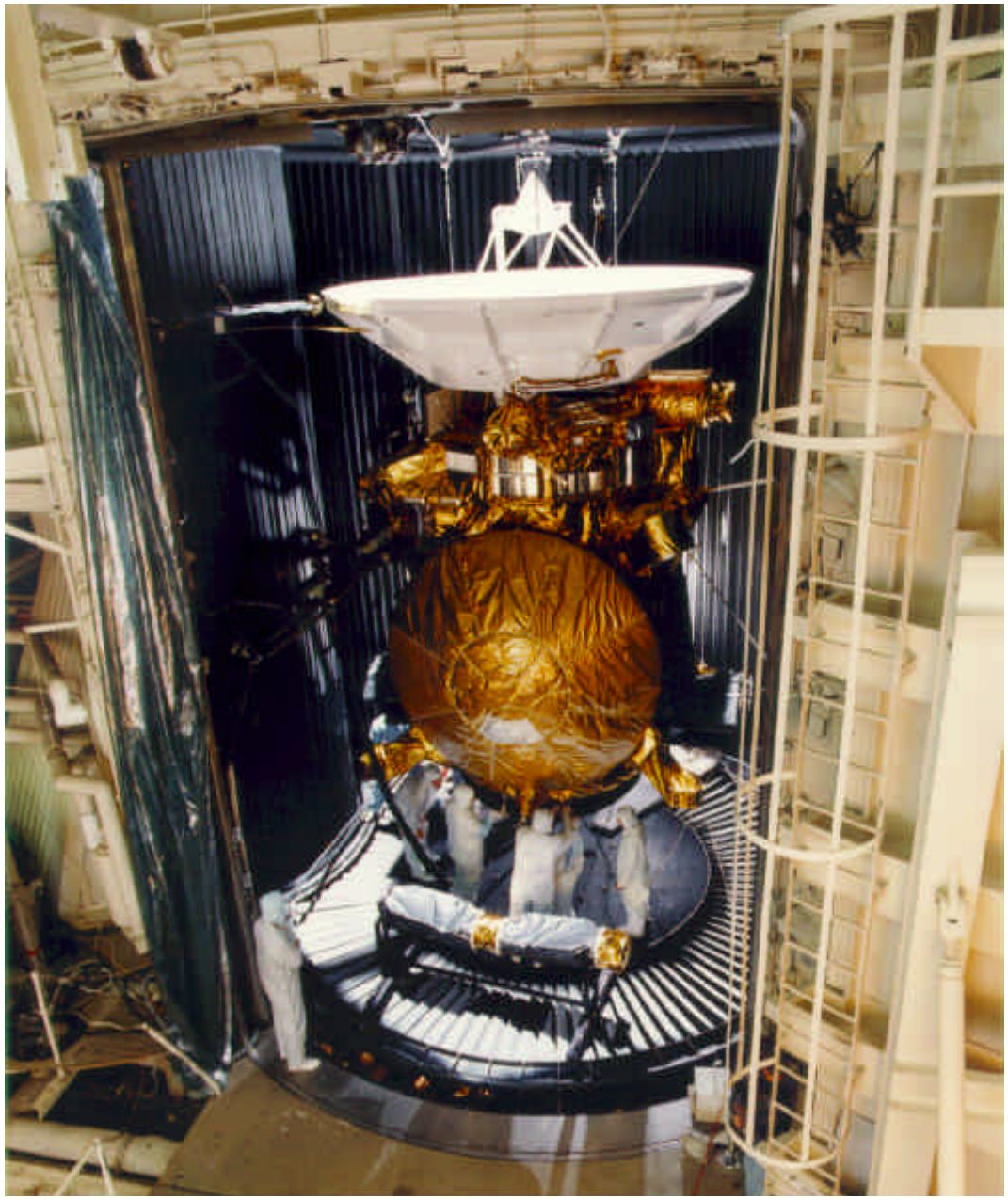
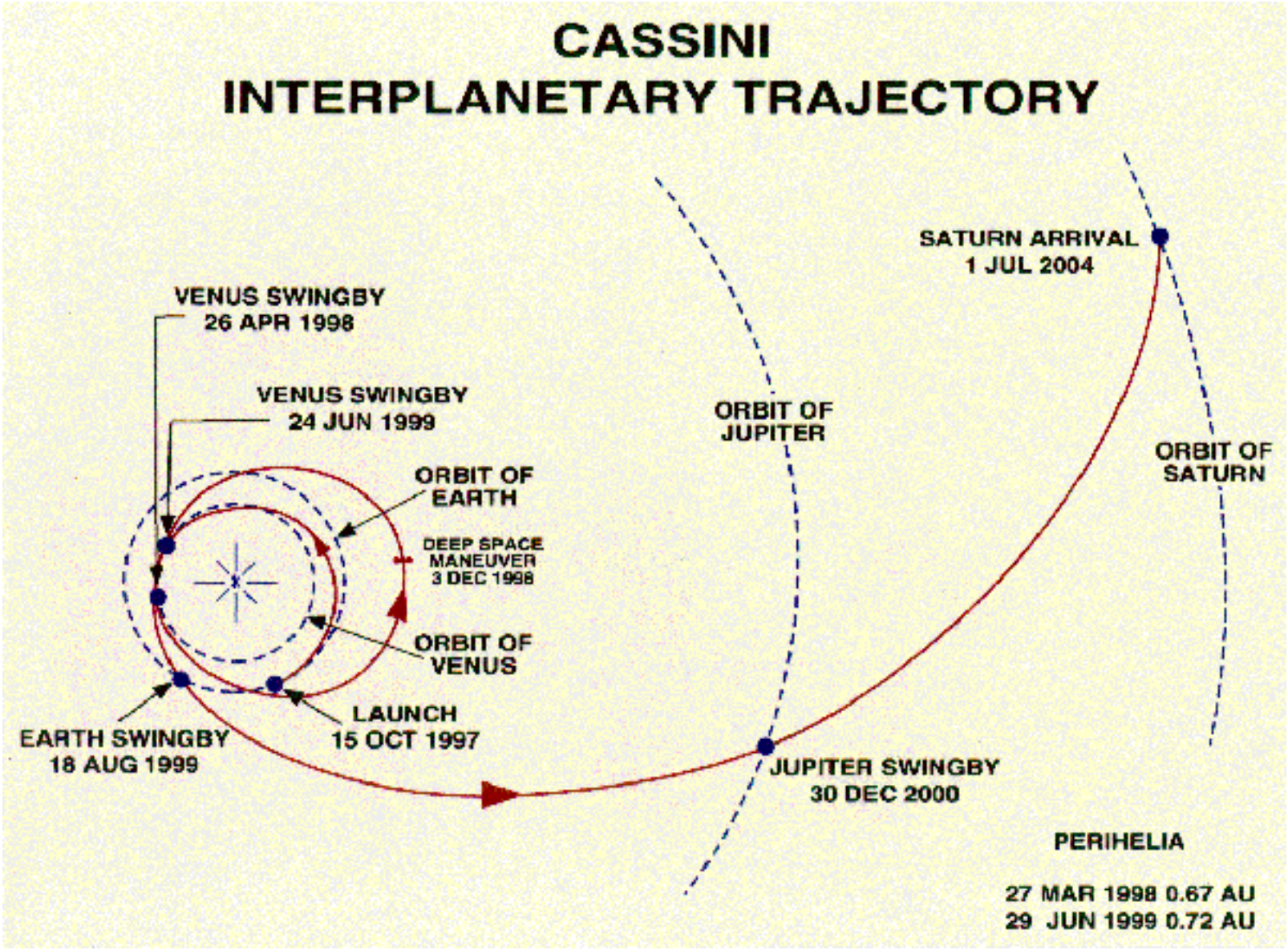
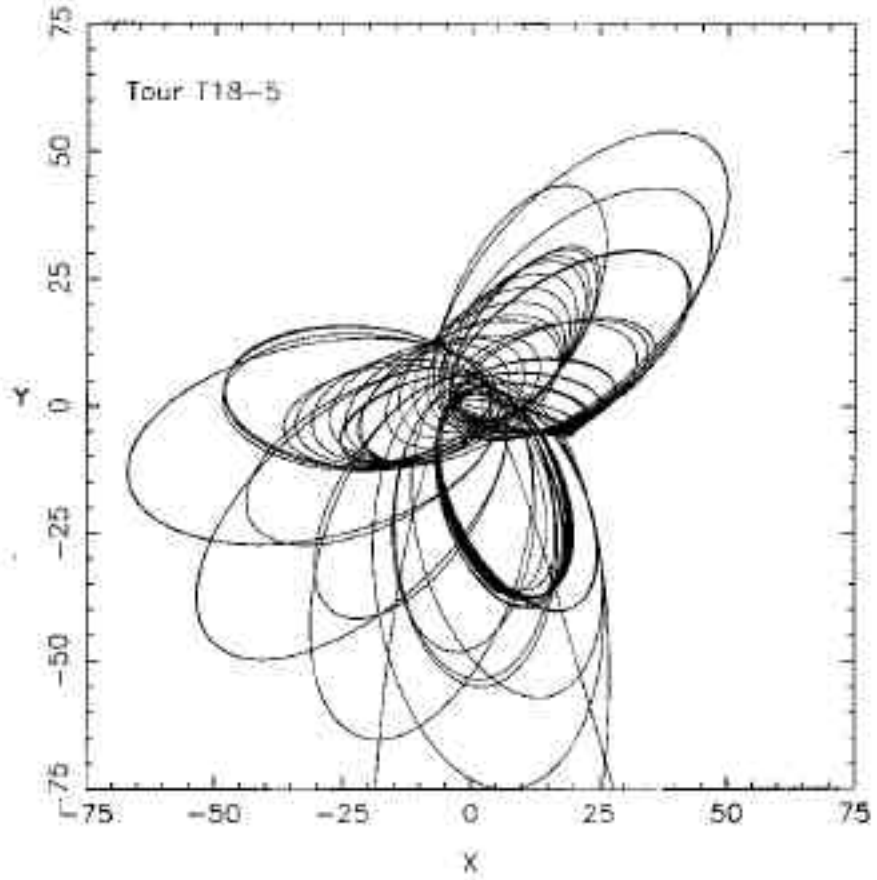
The Cassini Spacecraft in the Solar Thermal Vacuum Chamber

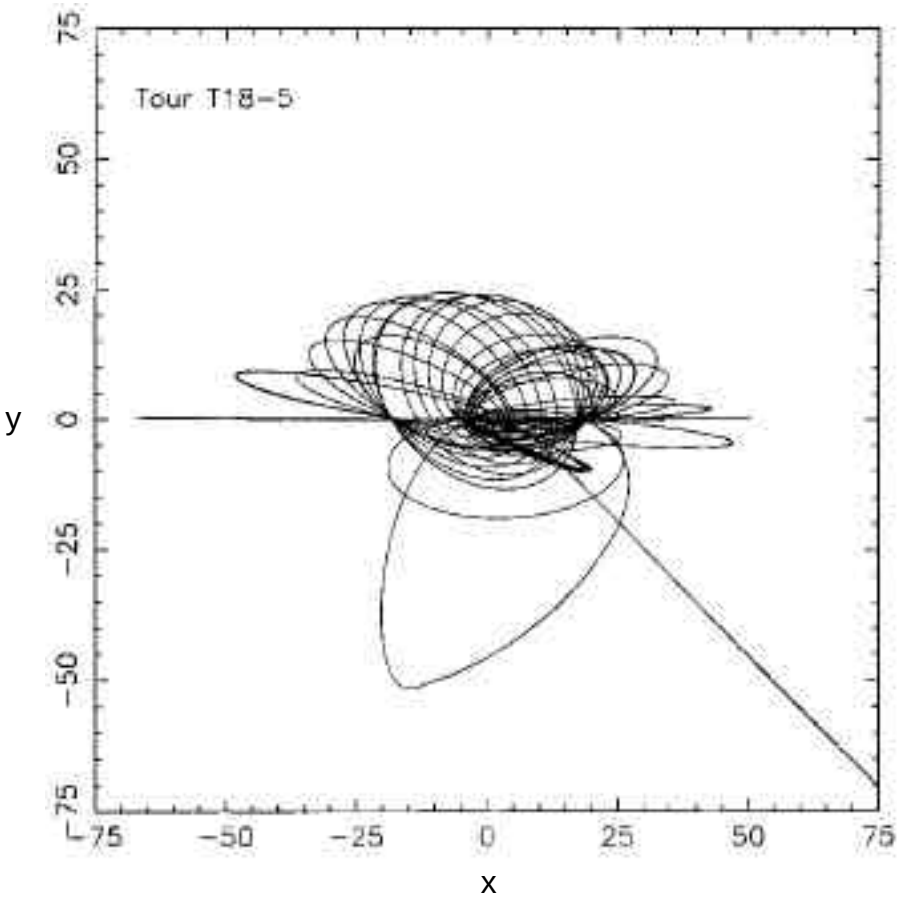


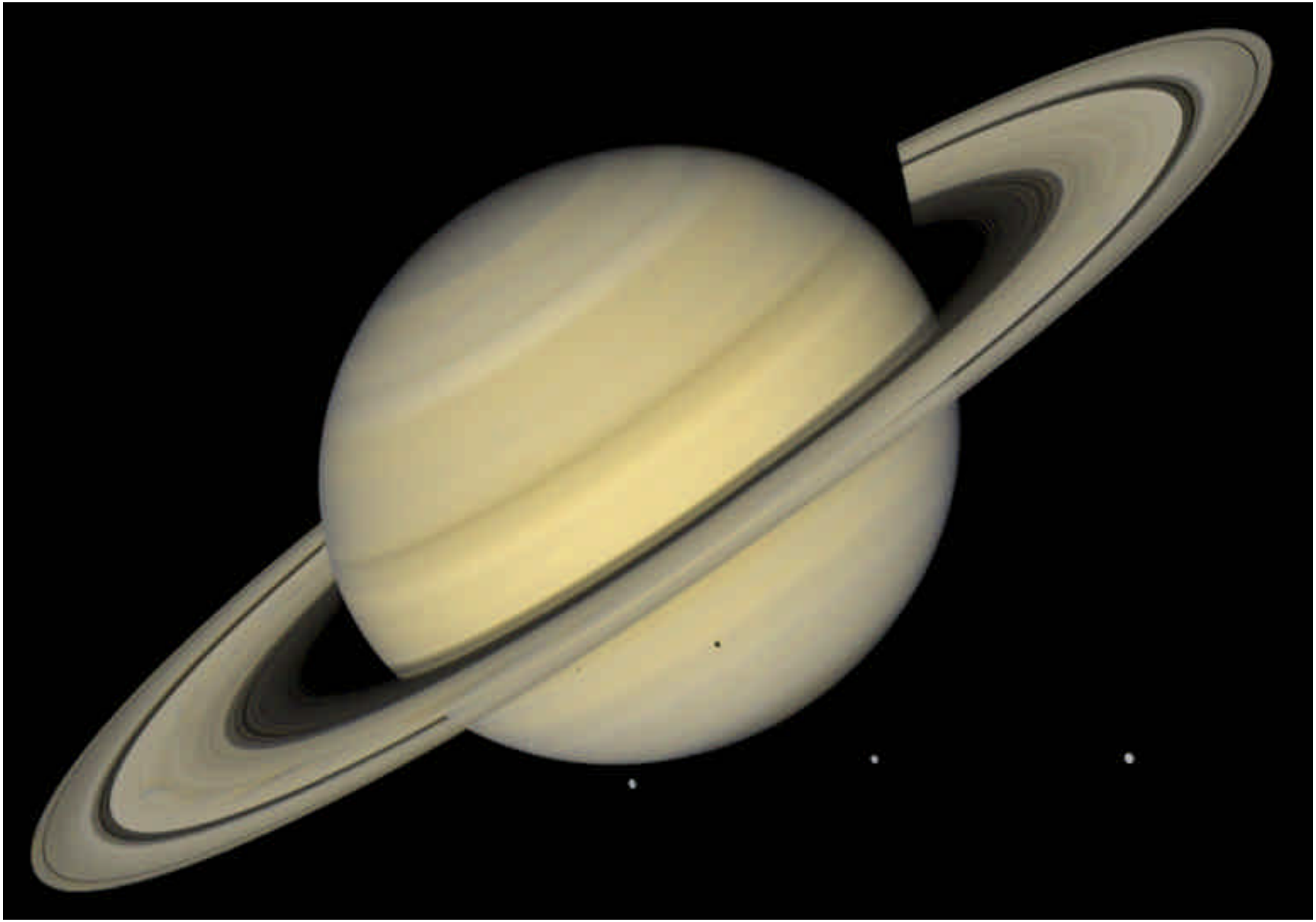
CASSINI
INTERPLANETARY TRAJECTORY



Cassini Orbital Tour at Saturn







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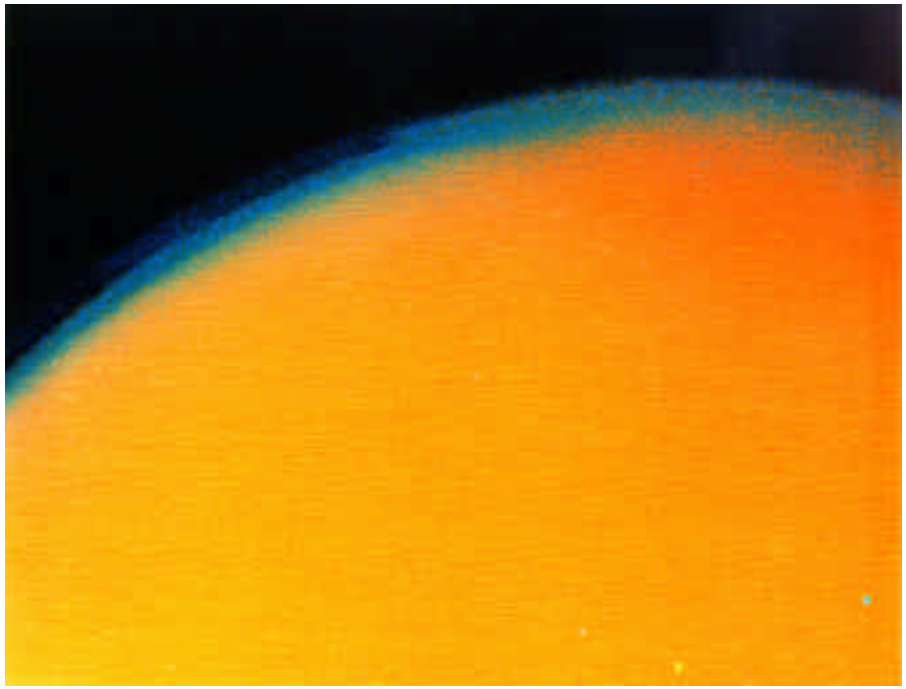
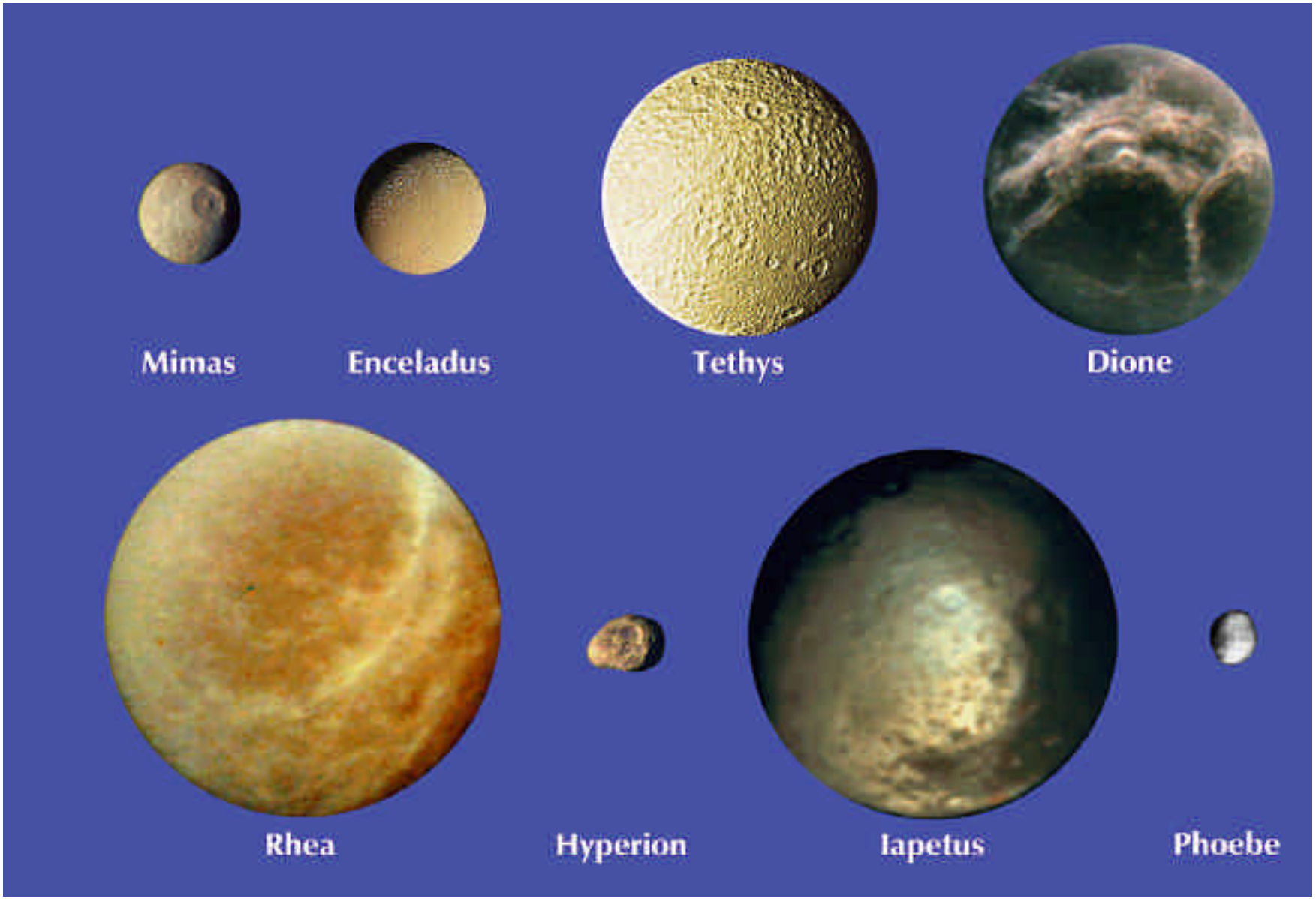
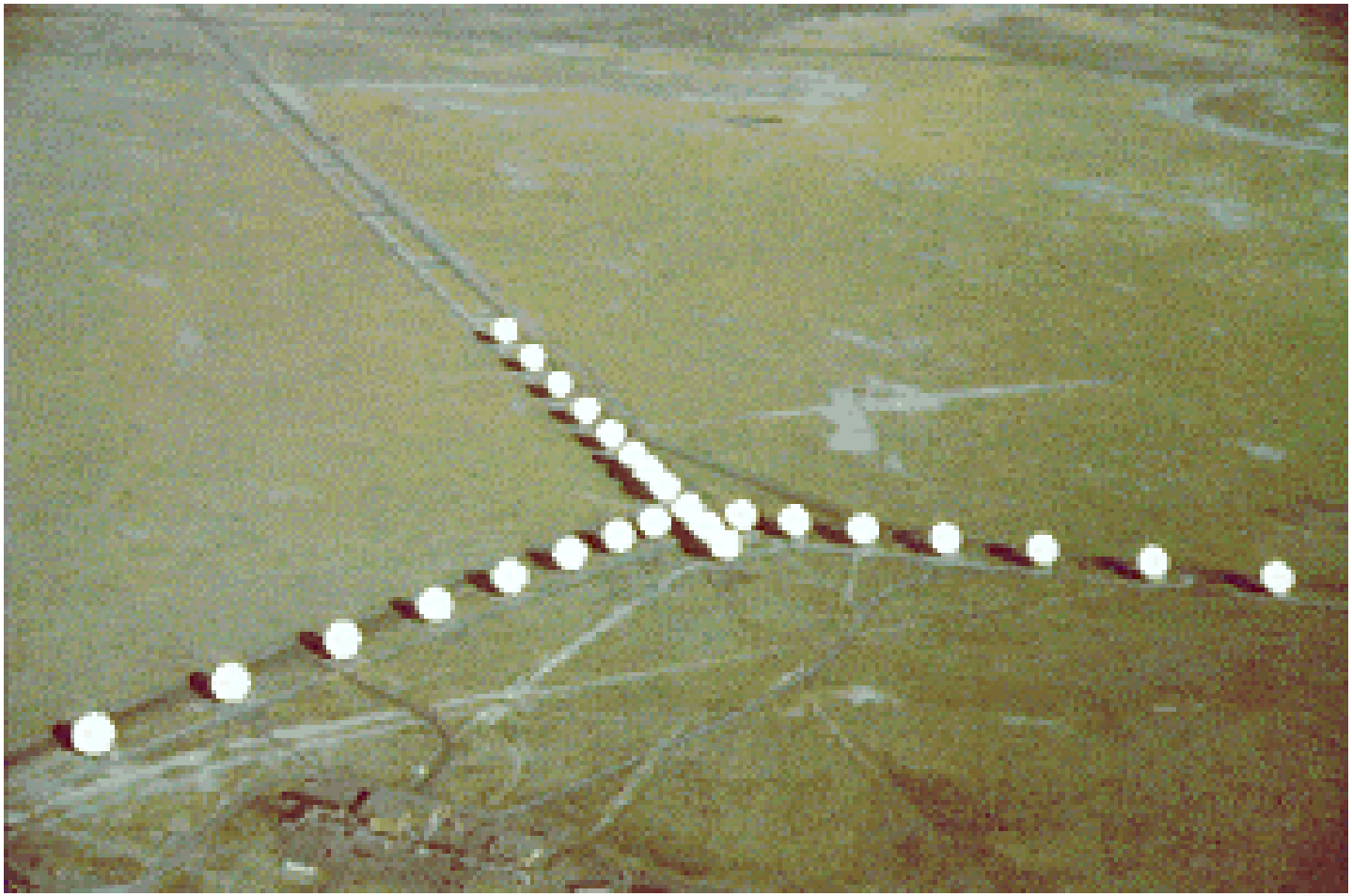
Titan Northern Hemisphere

Titan Haze

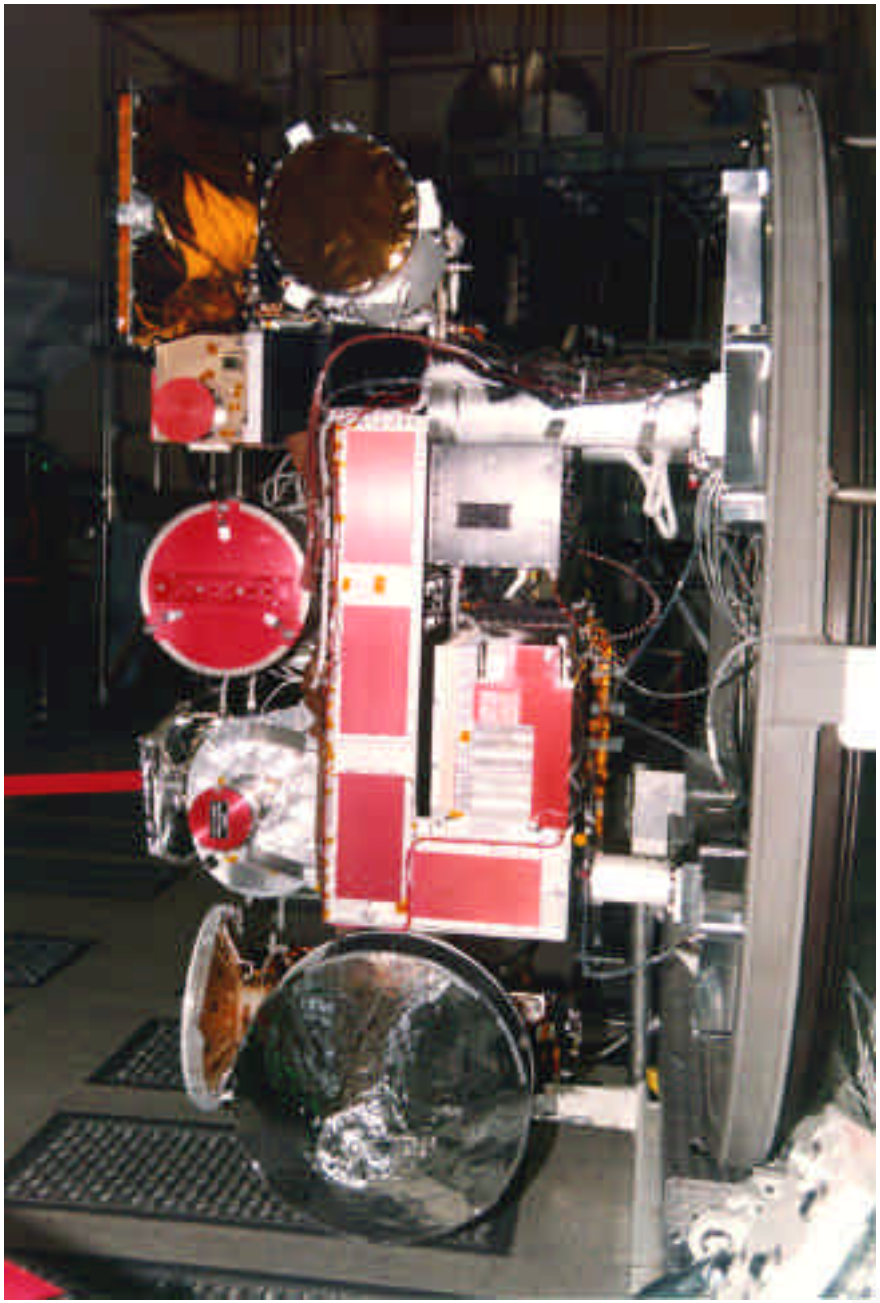



Mimas
Enceladus
Tethys
Dione
Rhea
Hyperion
Iapetus
Phoebe

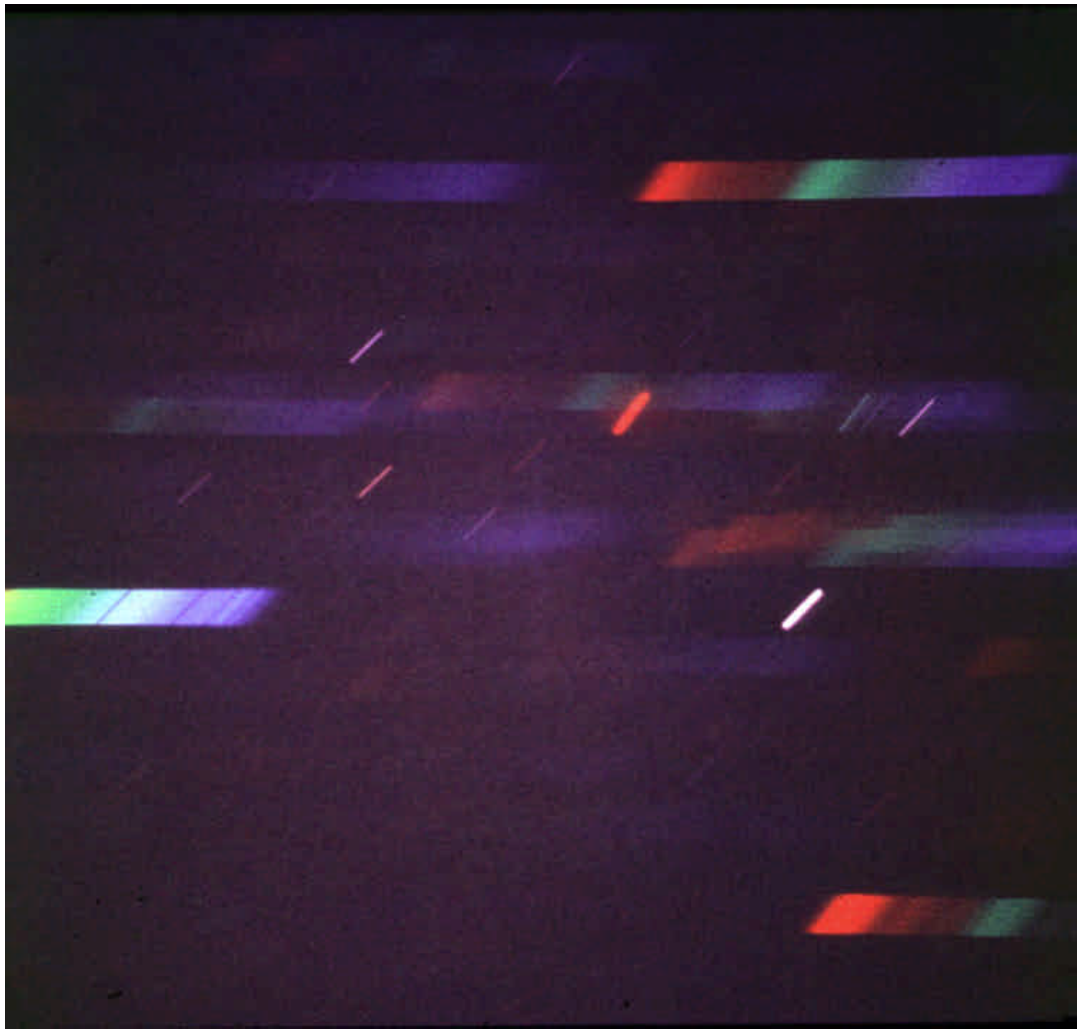
Very Large Array



CIRS Instrument on Cassini Remote Sensing Pallet



Spectrum of Sirius



CIRS
Description of Investigation

- Infrared Spectroscopy of Emission from Atmospheres, Rings, and Surfaces in

  10 - 1400 cm^{-1} (1000 - 7 micron) Region
- Global Mapping in Saturn's and Titan's Atmospheres of The Three Dimensional and Temporal Variation of:
  - Temperatures
  - Gas Composition
  - Aerosols, Clouds
- Global Mapping of Saturn's Rings and Icy Satellite Surfaces for:
  - Composition and Thermal Properties
- Nadir and Limb Observational Modes. Limb Scanning Provides Scale Height Altitude Resolution.

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CIRS Measurement Capabilities

Science Objectives

Saturn, Titan Atmospheres

Map Global Thermal Structure	***Dynamics, General Circulation***
Map Global Gas Composition	***Photochem, Dynamics, Evolution***
Map Global Information on Hazes & Clouds	***Haze Formation, Cloud Physics***
Determine Information on Non-equilib Processes	***Energetics***
Search for New Molecular Species	***Photochemistry, Evolution***

Titan Surface

Map/Global Surface Temperature	***Lower Atmosphere Dynamics***

Rings and Icy Satellites

Map Composition Thermal Characteristics Map Thermal Characteristics	***Origin, Evolution, and Process***

CIRS
Improvements Over Voyager IRIS

- Increased Altitude Resolution With Limb Sounding (3 ➡ $1H_T$)
- Increased Sensitivity In Mid-IR
- Extended Spectral Coverage To Far-IR (10-200 cm^{-1})
- Increased Spectral Resolution (4.3 ➡ 0.5 cm^{-1})
- Extended Spatial And Seasonal Coverage

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CIRS
Top-Level Science Requirements

- Spectral Range: 1000 microns To 7.14 microns
  - Band 1 (FP1): 1000 - 16.7 microns (10 - 600 cm^{-1})
  - Band 2 (FP3): 16.7 - 9.1 microns (600 - 1100 cm^{-1})
  - Band 3 (FP4): 9.1 - 7.1 microns (1100 - 1400 cm^{-1})
- Spectral Resolution: 0.5-20 cm^{-1}, Commandable
- Fields Of View (Geometric, Centered Between FP3 & FP4, Non-overlapping)
  - FP1: 4.3 mrad (Circular)
  - FP**3: 2.88 x 0.273 mrad (1 x 10 Array), 0.273 x 0.273 mrad Pixels**
  - FP**4: 2.88 x 0.273 mrad (1 x 10 Array), 0.273 x 0.273 mrad Pixels**

CIRS
Instrument Concept

- The Composite Infrared Spectrometer (CIRS) Consists Of Combined Far-IR And Mid-IR Fourier Transform Spectrometers.
- The Two Spectrometers Share a 50 cm, F/6 Telescope and Mirror Transport Mechanism.
- Overall Spectral Coverage Is 10 to 1400 cm^{-1} (1000-7 microns) and Spectral Resolution is 0.5 to 20 cm^{-1}.
- The Far-IR Spectrometer is a Polarizing Interferometer with a Single Focal Plane (FP1):
  - **FP1: 10 - 600 cm^{-1},** Two Thermopile Detectors
    4.3 mrad Field-of-view.
  - FP3: 600 - 1100 cm^{-1}, 1 x 10 HgCdTe Array
    0.273 mrad Field-of-View on Each Pixel.
  - FP4: 1100 - 1400 cm^{-1}, 1 x 10 HgCdTe Array
    0.273 mrad Field-of-View on Each Pixel.

Pixels on Each Array are Selectable in Sets of 5 Output Channels.

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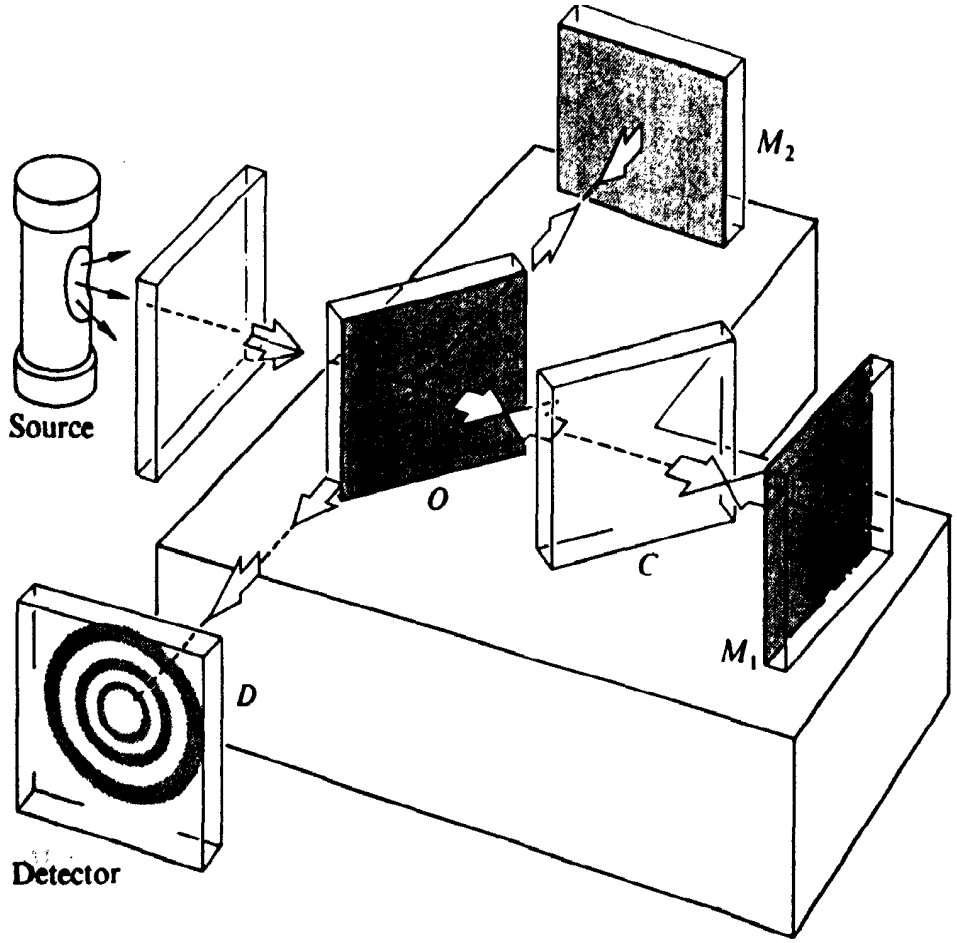
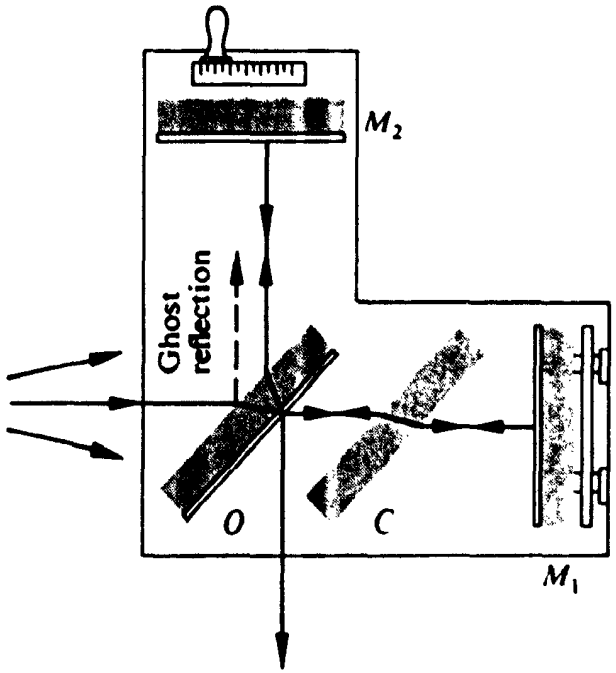
CIRS
INSTRUMENT SUMMARY

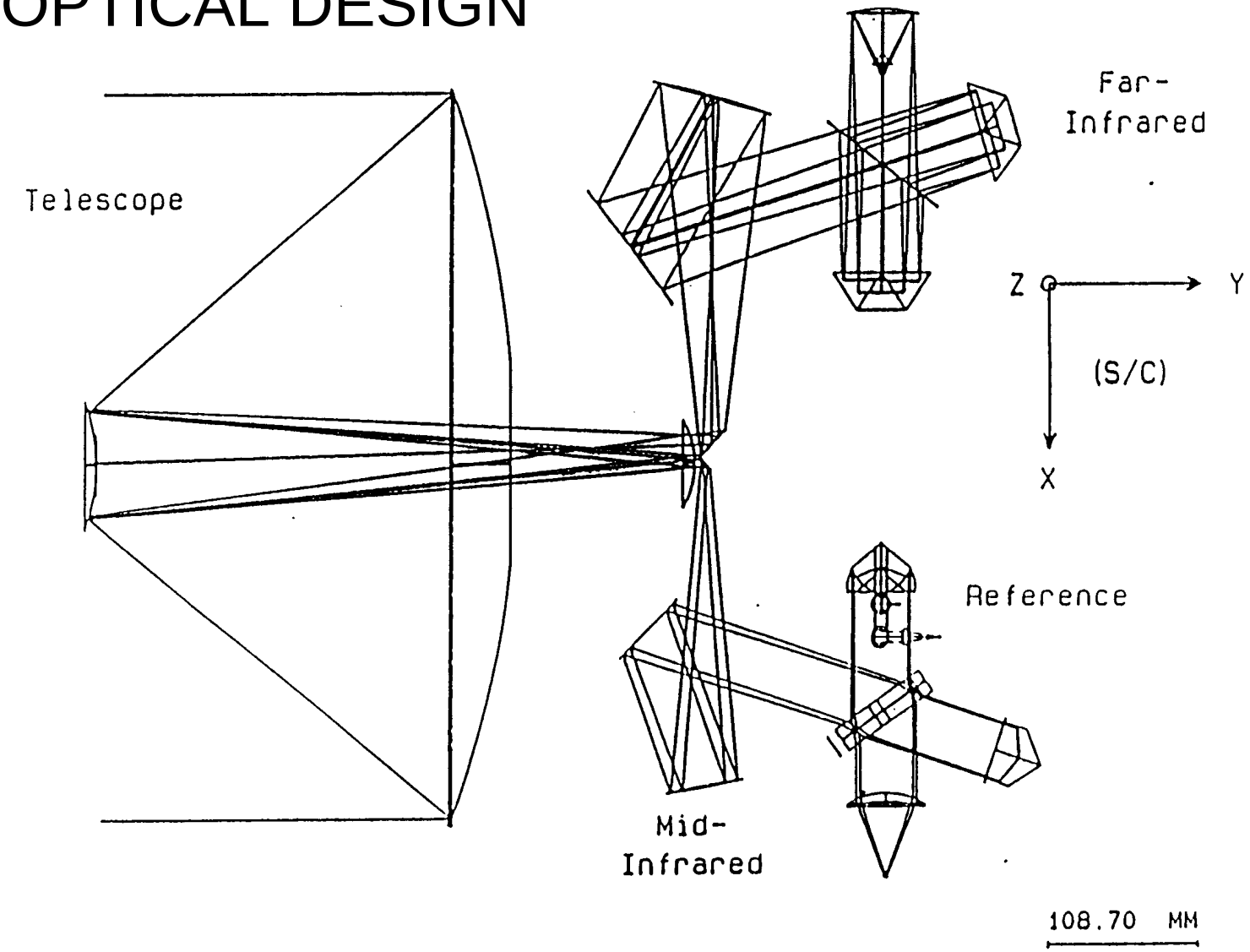
Telescope Diameter (cm)	50.8		
Interferometers:	FIR	MIR	
Type:	POLARIZING	MICHELSON	
Spectral Range (cm^{-1})	10-600	600-1400	
Spectral Resolution (cm^{-1})	0.5-20	0.5-20	
Integration Time (sec)	50-2	50-2	
Focal Planes:	FP1	FP3	FP4
Spectral Range (cm^{-1})	10-600	600-110	1100-11400
Detectors:	Thermopile (2)	HgCdTe (1x10)	HgCdTe (1x10)
Pixel FOV (mrad)	4.3	0.273	0.273
Operating Temperature (K) (Stability +/- 0.1 K)	170	70,75,80,85	70,75,80,85

MICHELSON INTERFEROMETER

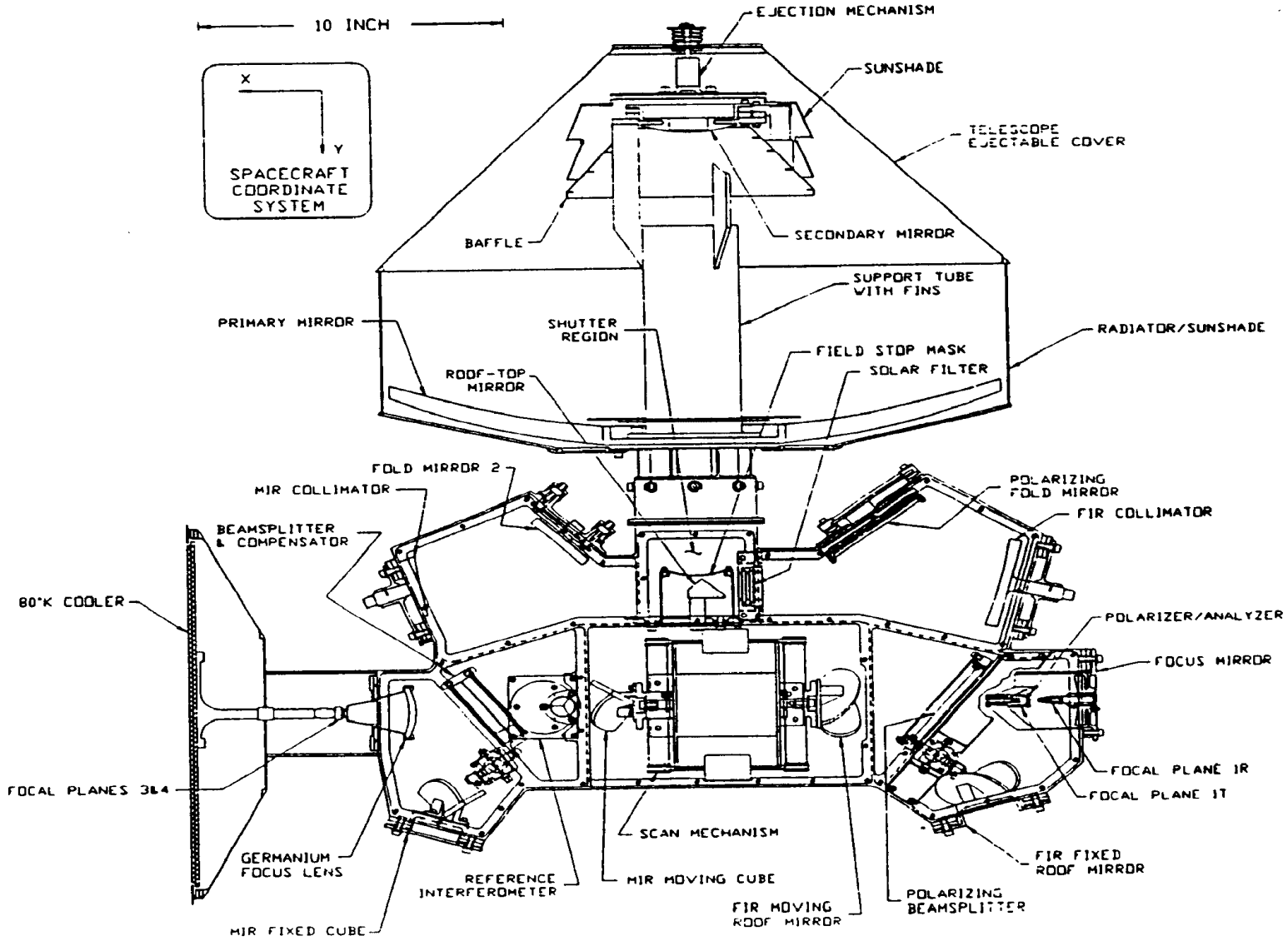




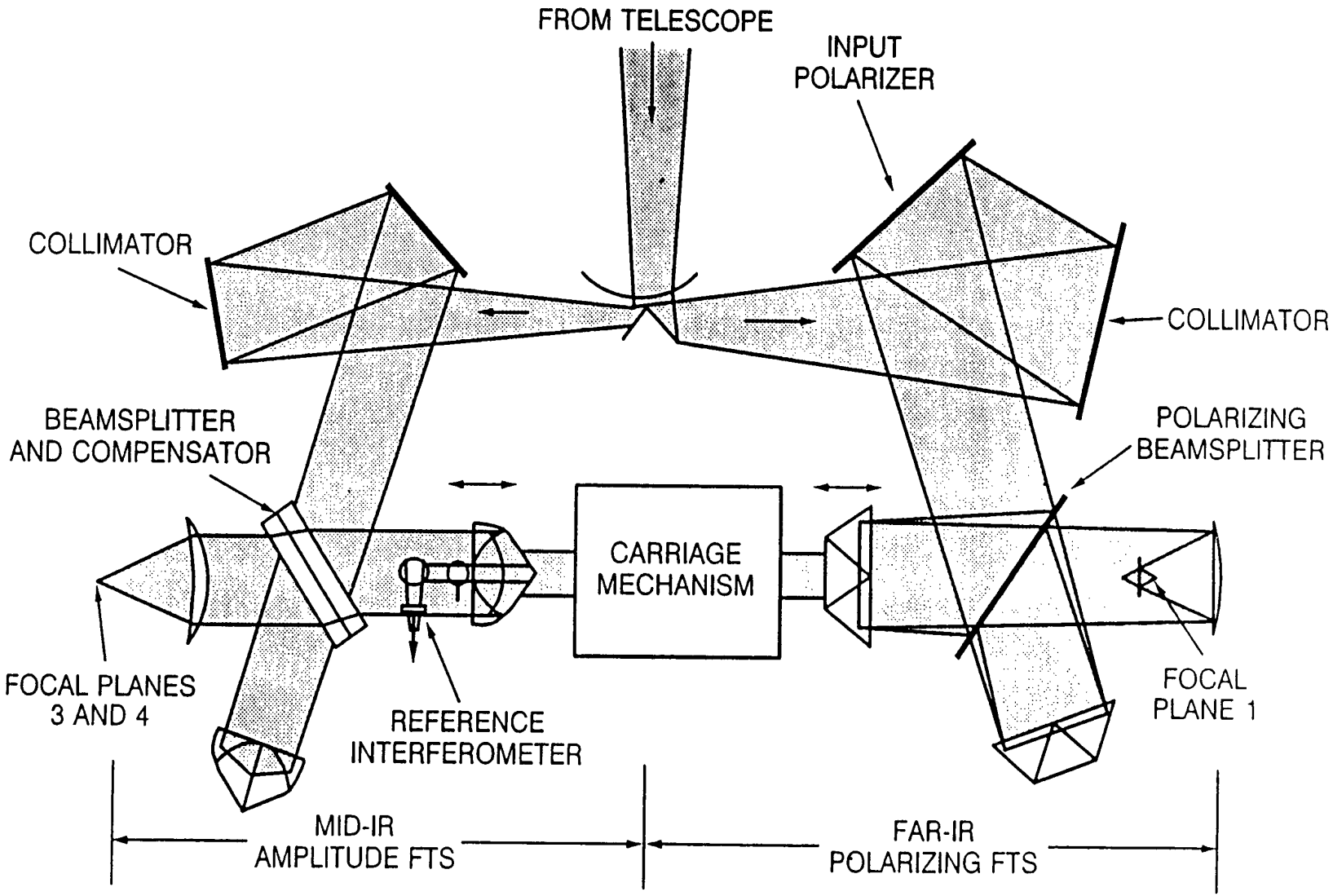
CIRS
OPTICAL DESIGN



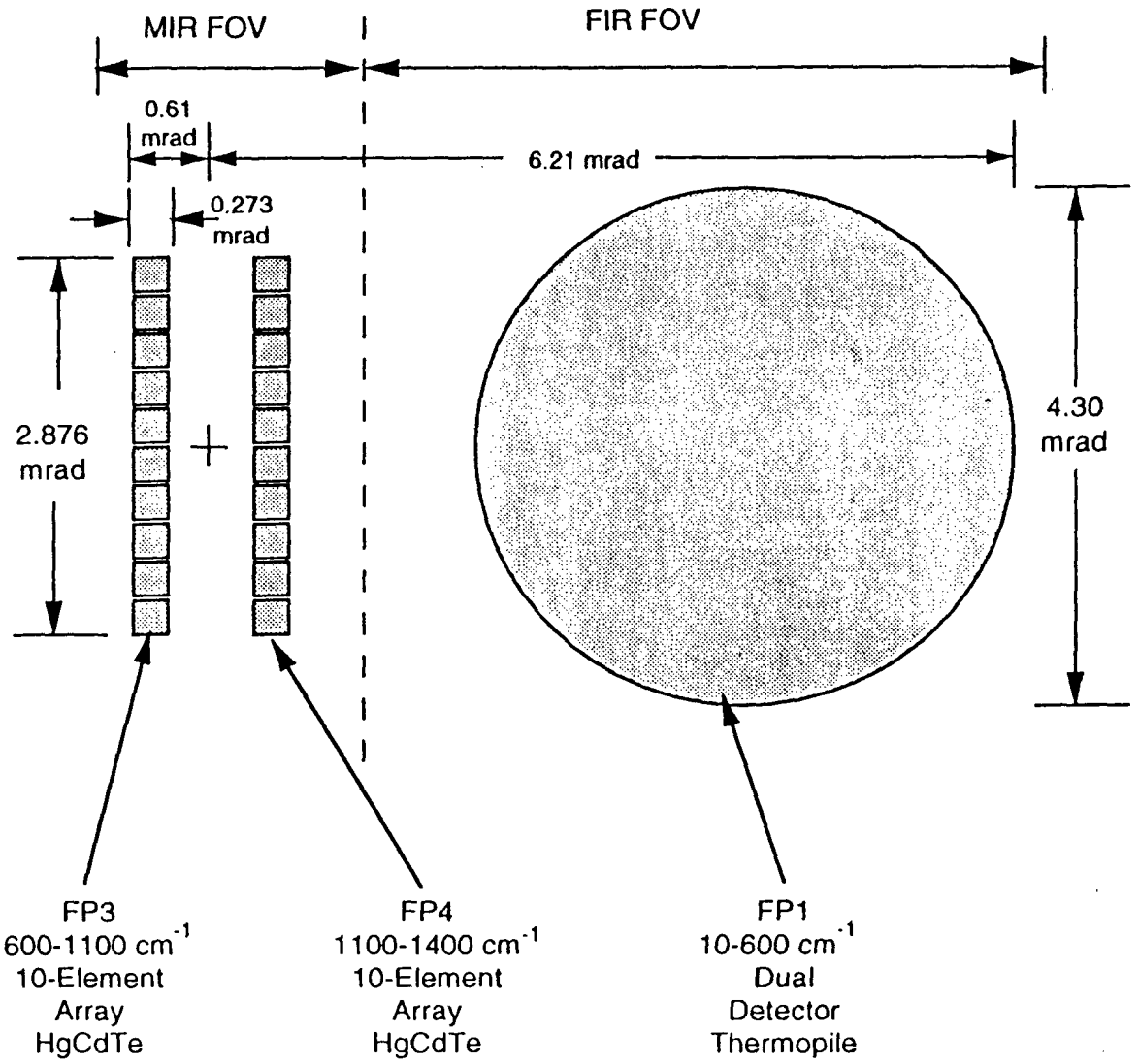
CIRS
INSTRUMENT LAYOUT



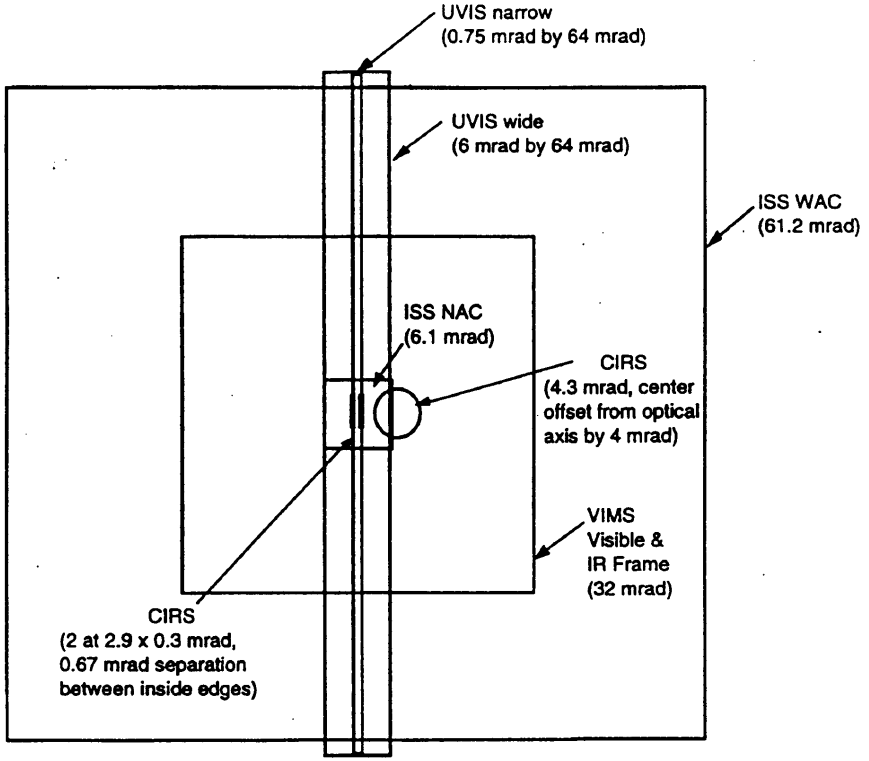
CIRS
CONCEPTUAL LAYOUT



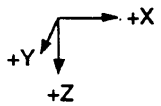
CIRS
FIELDS OF VIEW (FOV)



CASSINI
OPTICAL REMOTE SENSING FIELDS OF VIEW

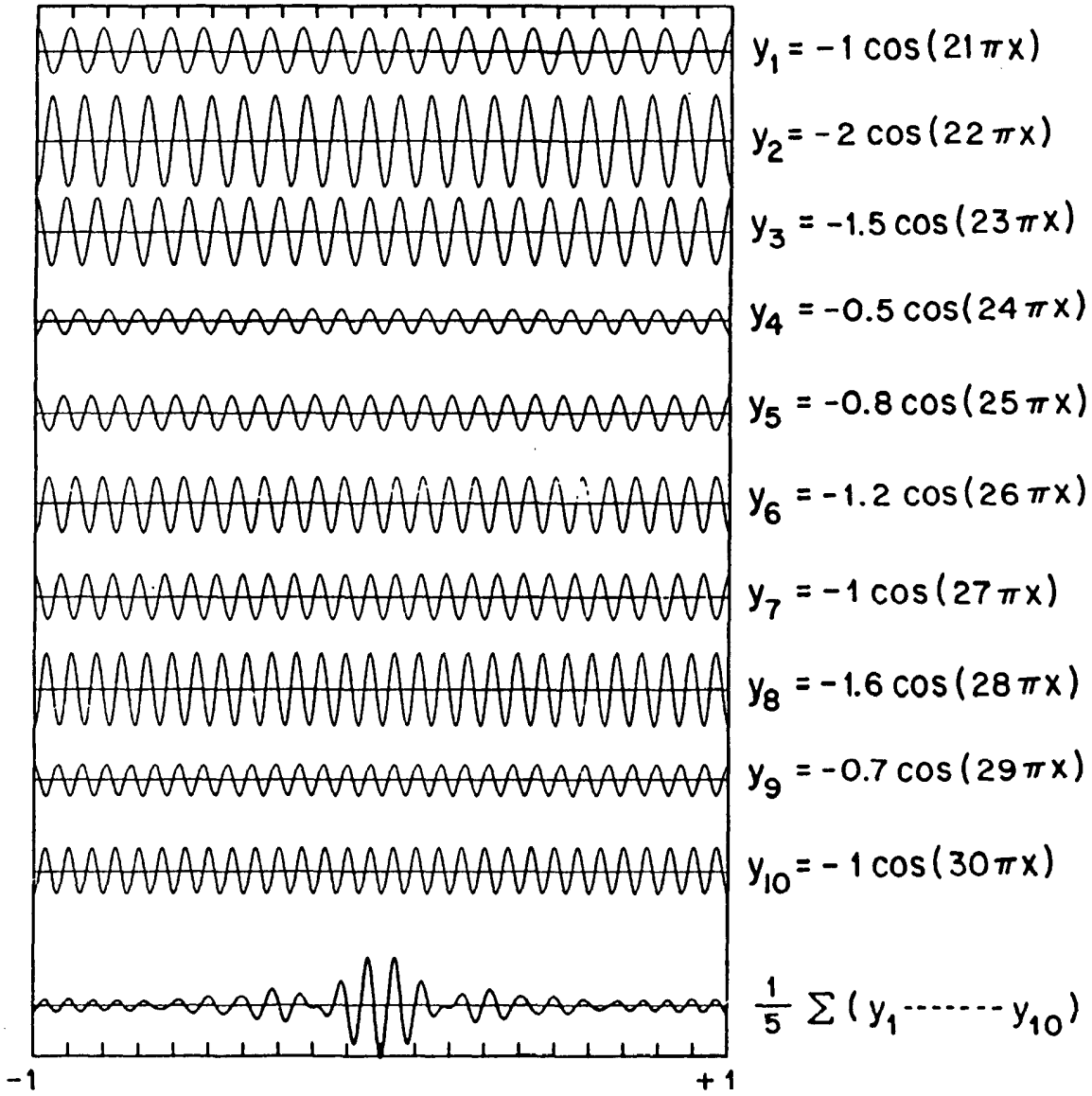


PROJECTION ON SKY (ALONG -Y AXIS)

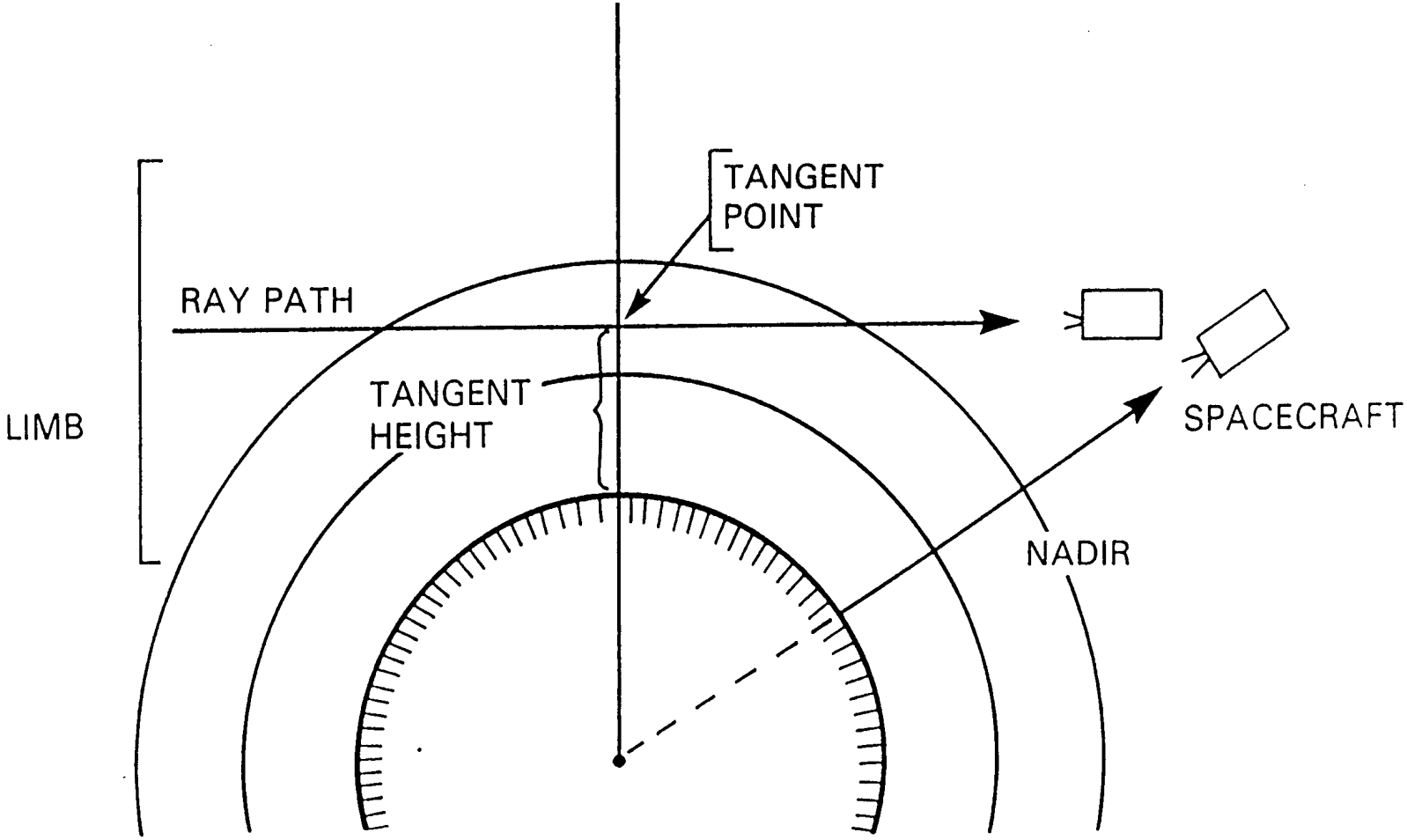


SPACECRAFT AXES

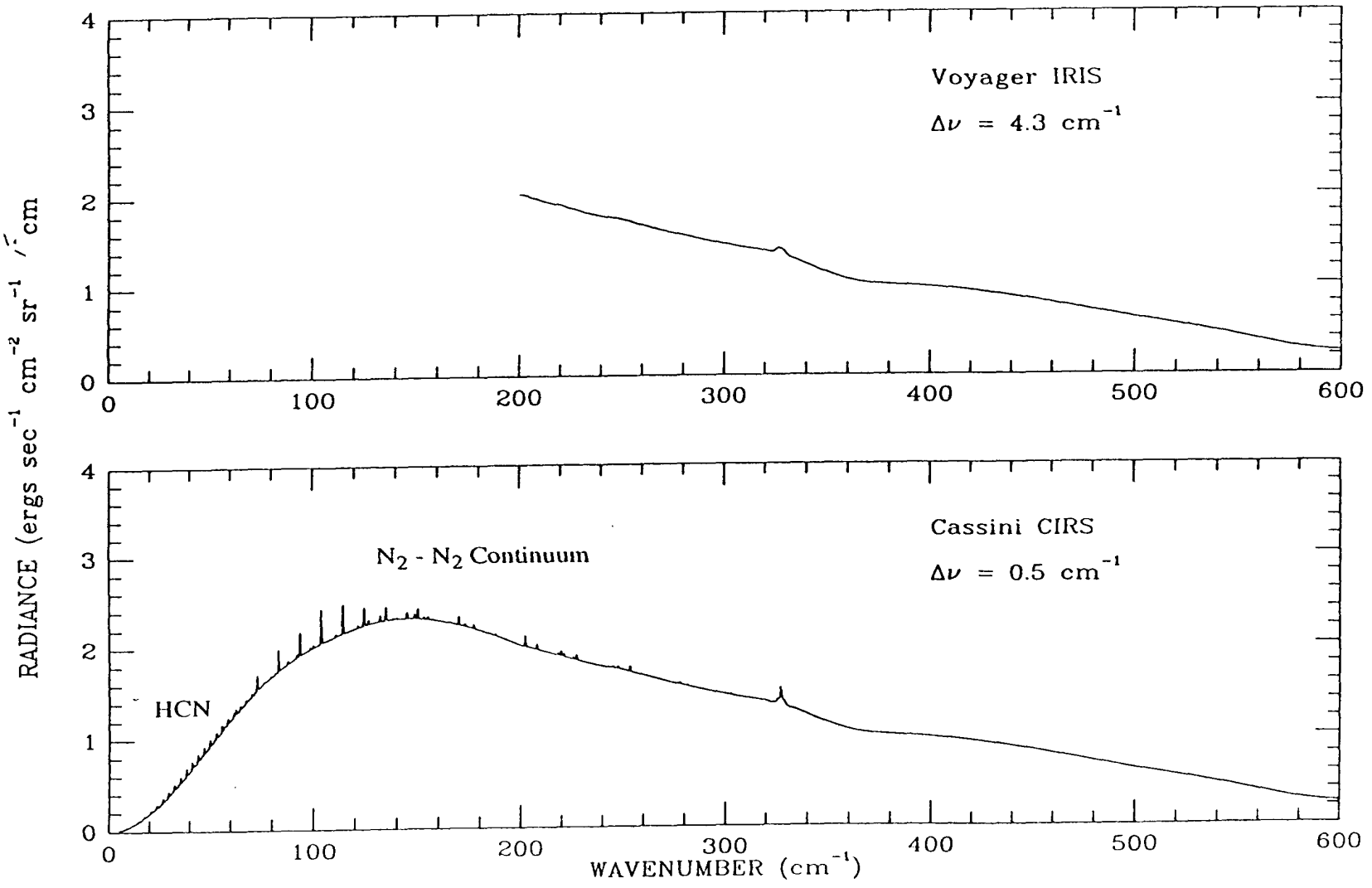
Composition of Interferogram



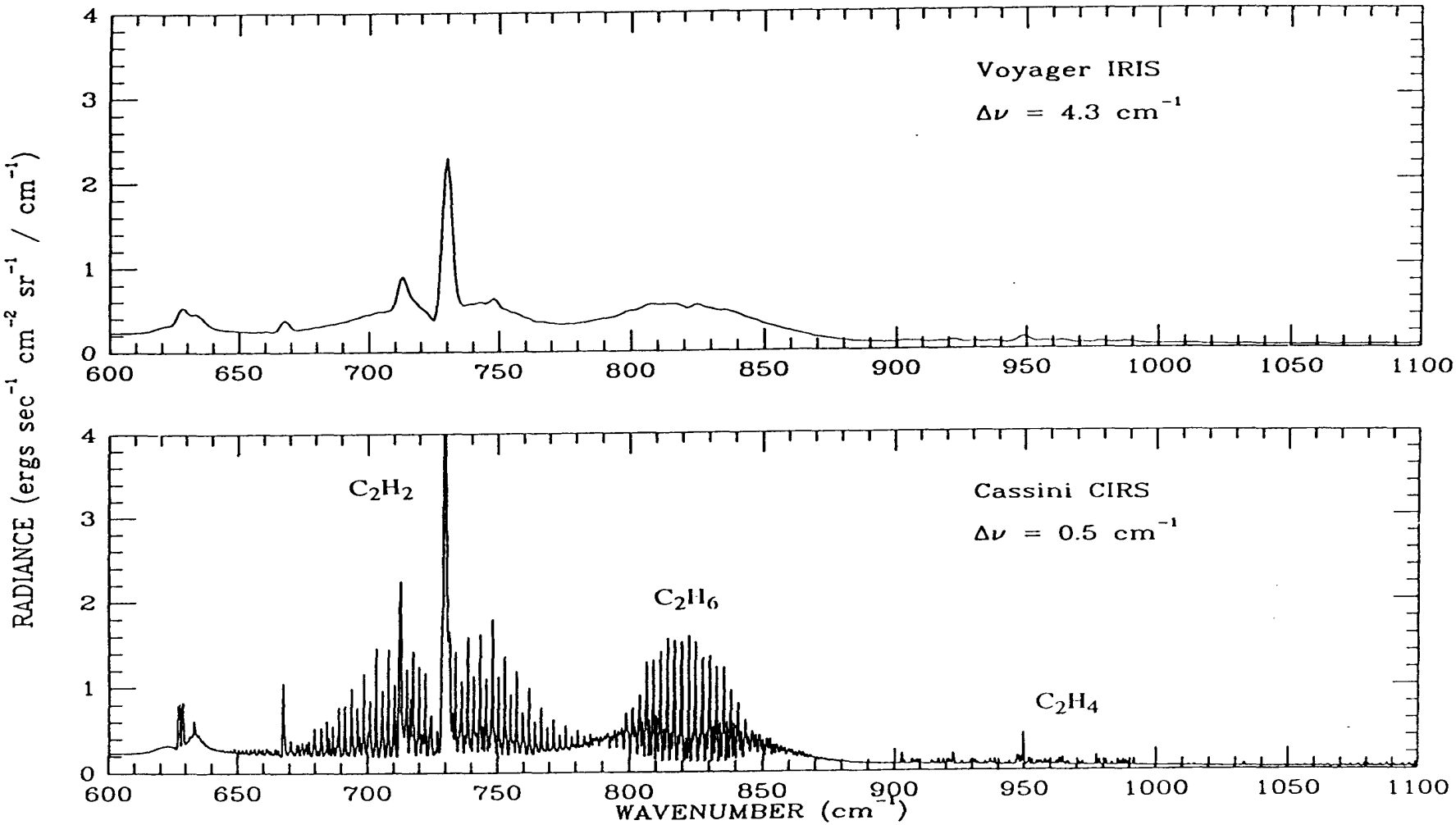
CIRS
VIEWING GEOMETRY



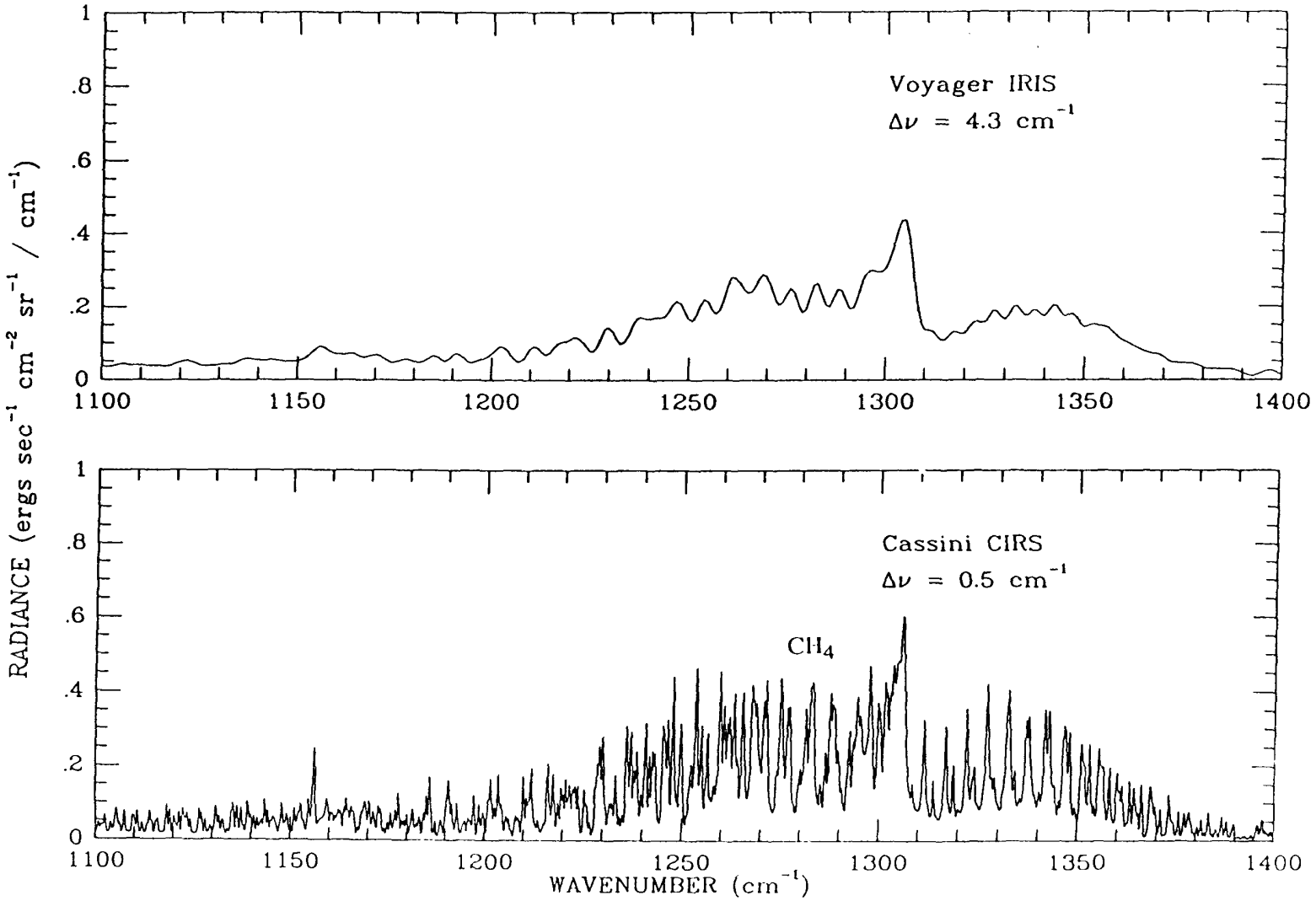
TITAN SYNTHETIC NADIR SPECTRUM



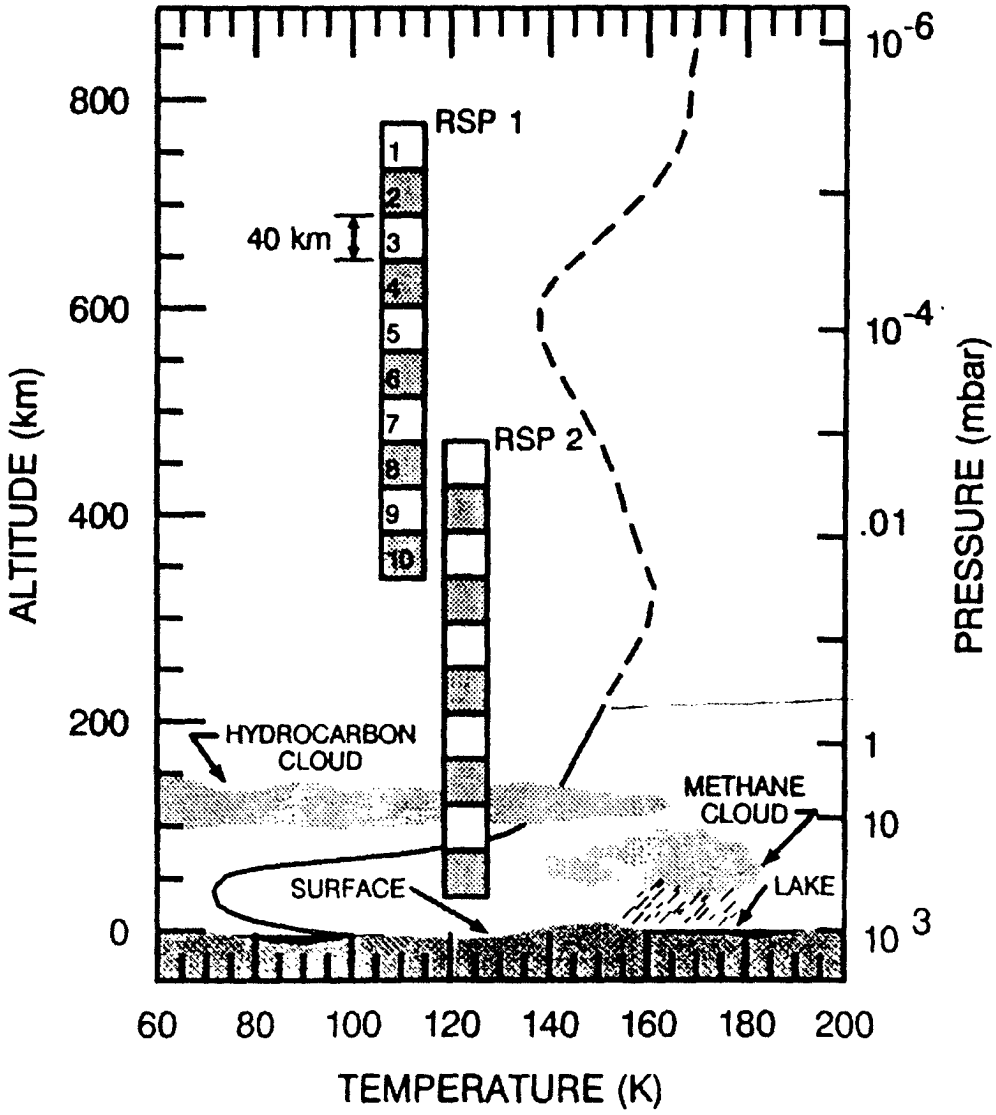
TITAN SYNTHETIC NADIR SPECTRUM FOCAL PLANE 3



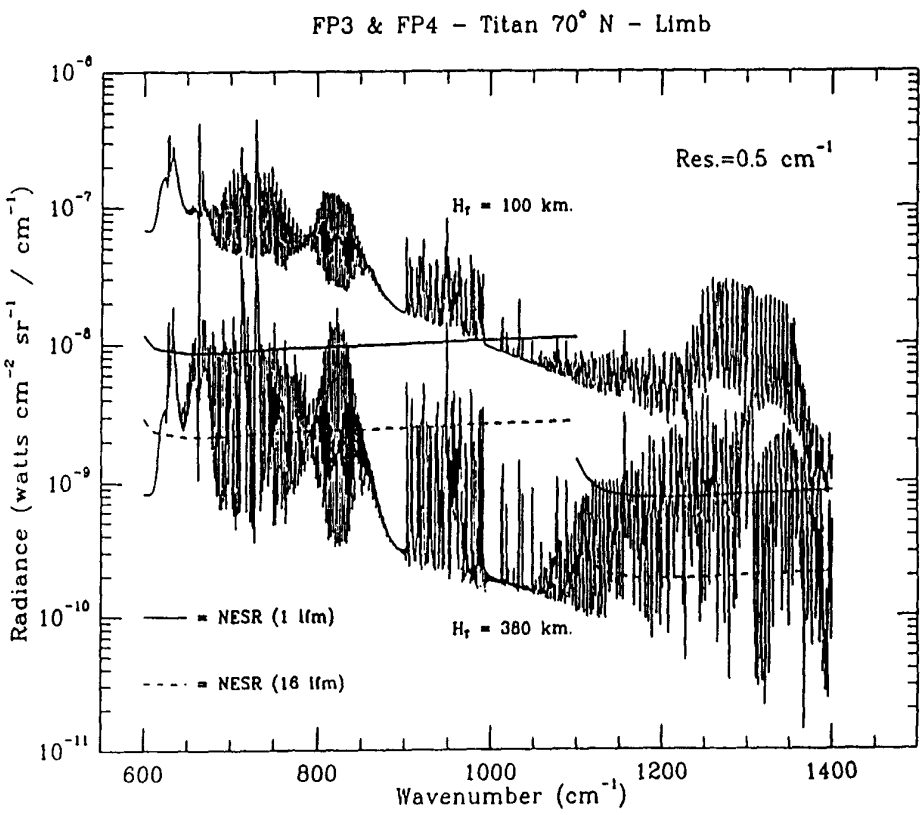
TITAN SYNTHETIC NADIR SPECTRUM FOCAL PLANE 4

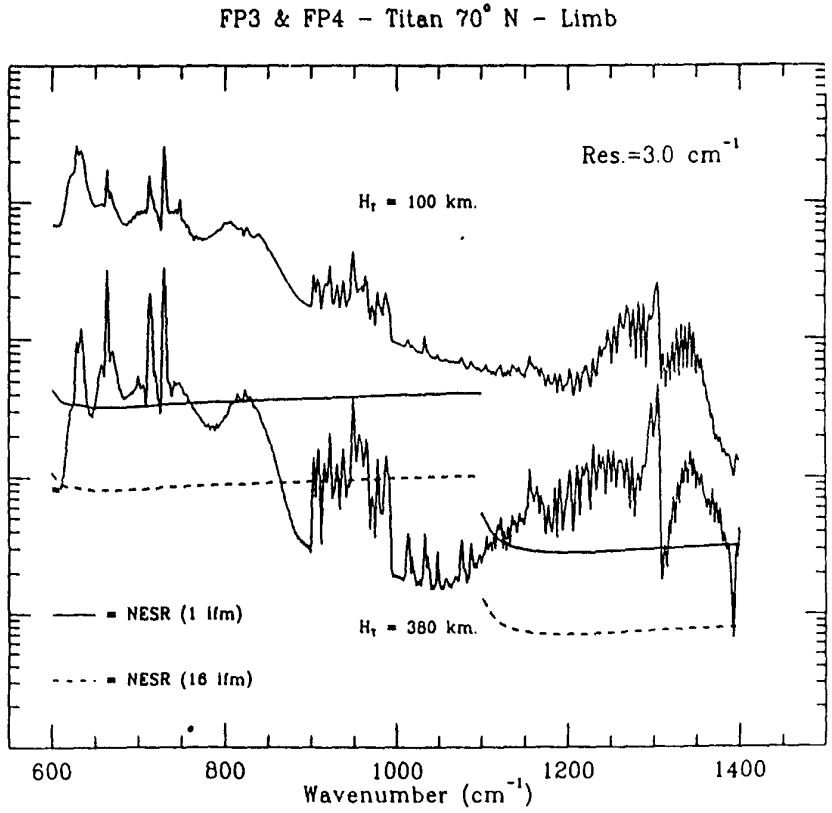


CIRS
FOCAL PLANE 3, 4 LIMB COVERAGE

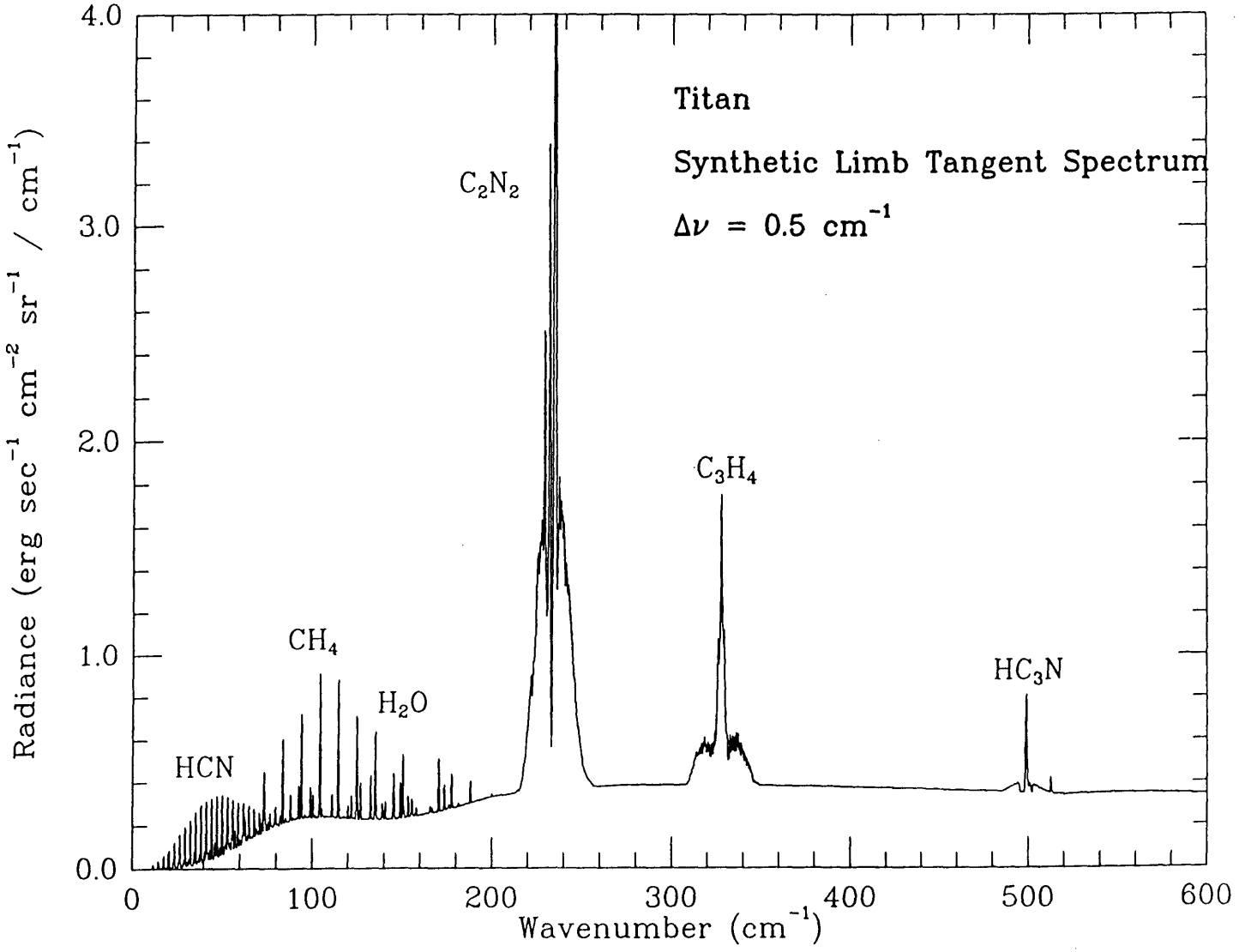


CIRS
EXPECTED PERFORMANCE: TITAN LIMB VIEWING

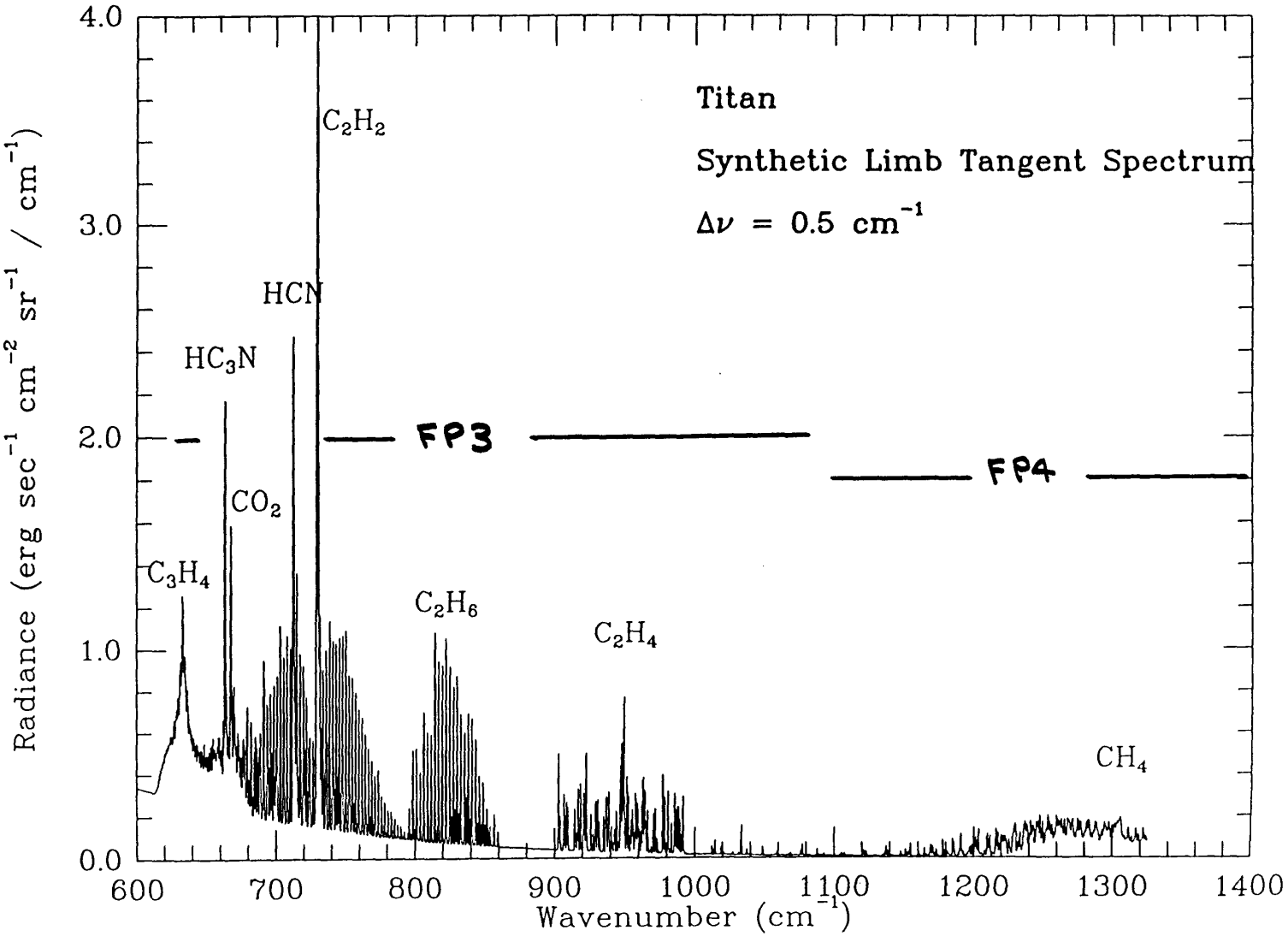




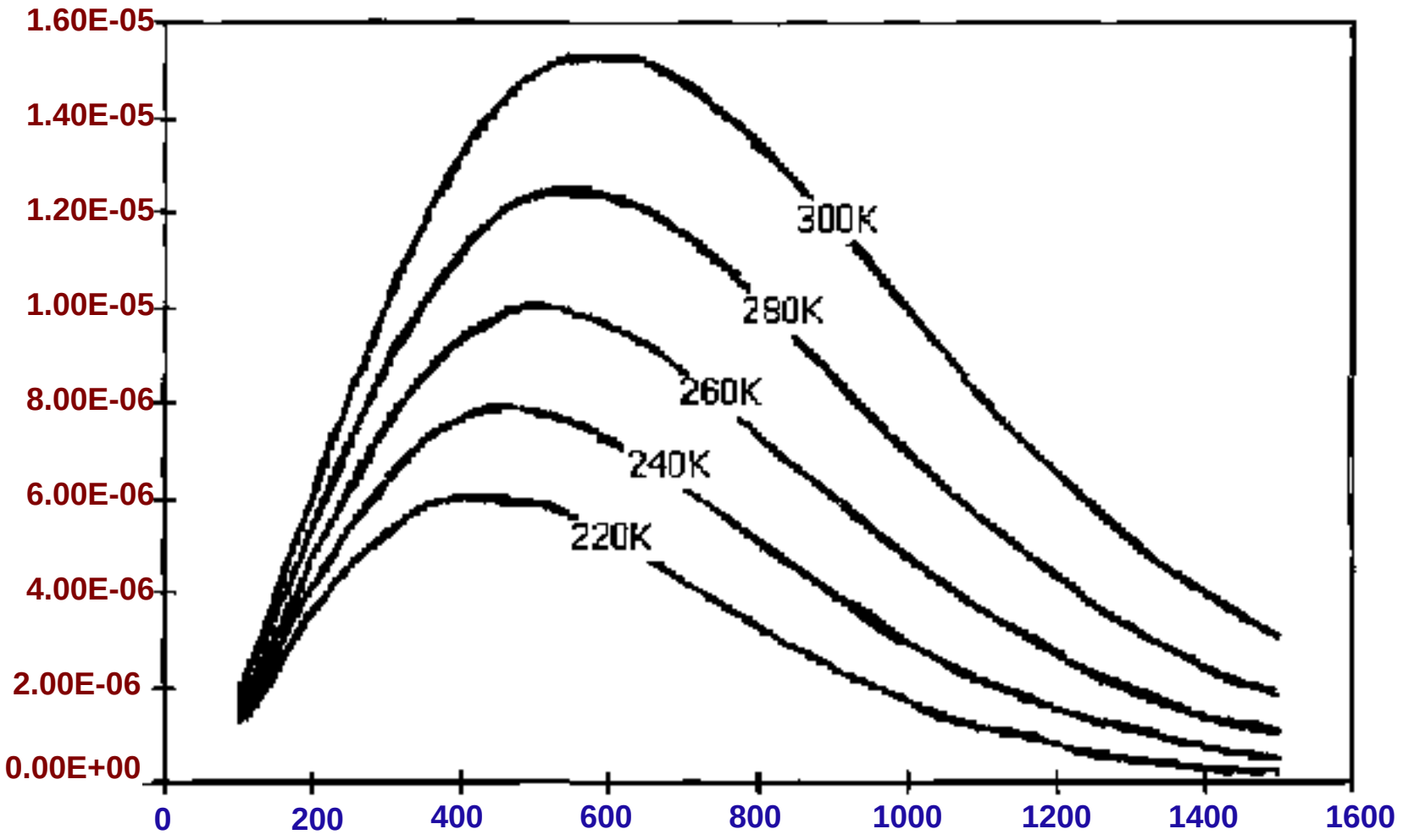
CIRS
FOCAL PLANE 1



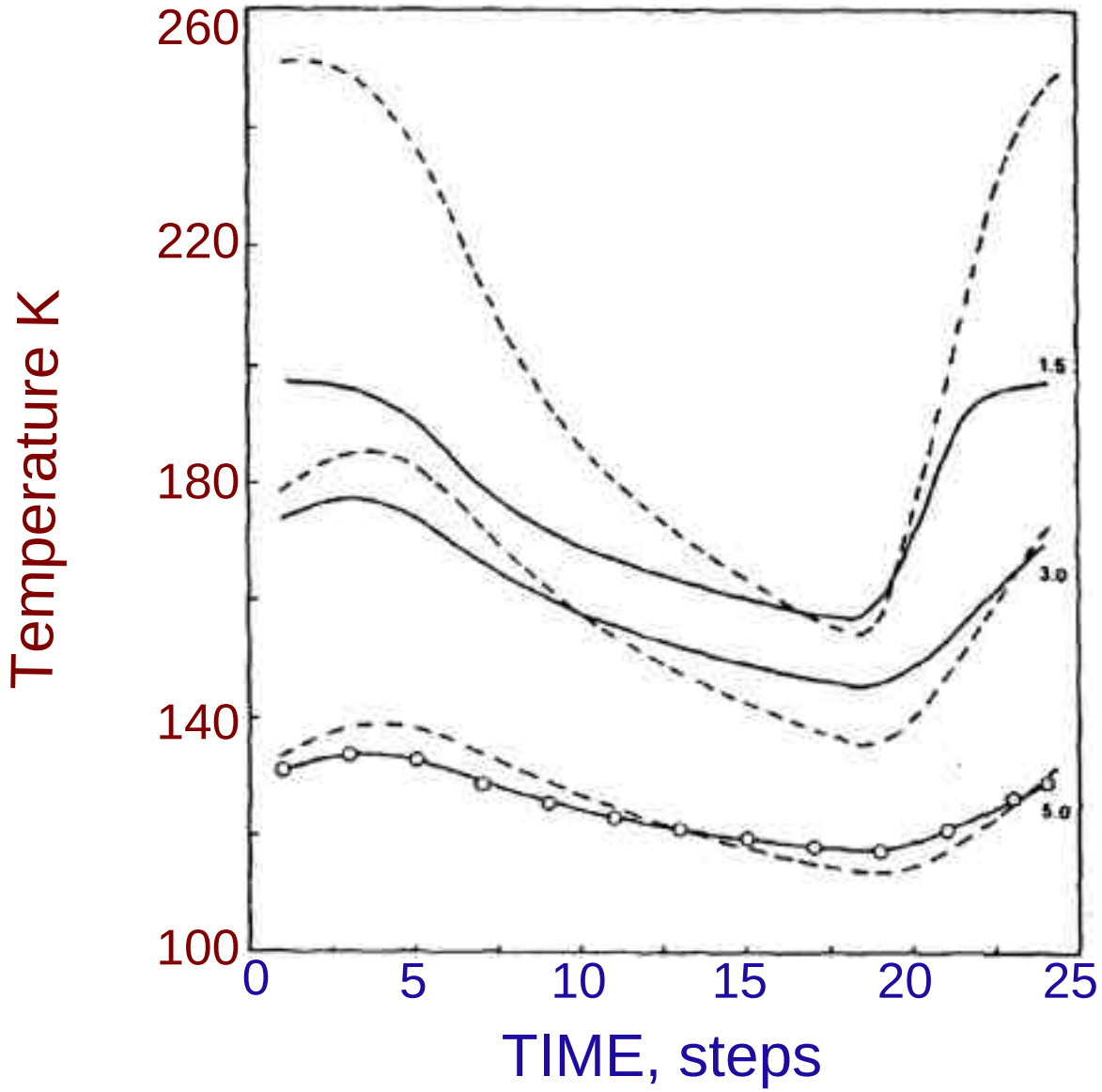
CIRS
FOCAL PLANE 3, FOCAL PLANE 4



Blackbody Radiation



Diurnal Temperatures



CIRS Instrument Web Sites

http://www701.gsfc.nasa.gov/cirs/inst.htm

http://www.jpl.nasa.gov/cassini/Science/MAPS/CIRS.html

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